

**IN THE UNITED STATES DISTRICT COURT  
FOR THE DISTRICT OF DELAWARE**

LG.PHILIPS LCD CO., LTD. and  
LG.PHILIPS LCD AMERICA, INC.,

*Plaintiff,*

vs.

AU OPTRONICS CORPORATION;  
AU OPTRONICS CORPORATION  
AMERICA; CHI MEI OPTOELECTRONICS  
CORPORATION; and CHI MEI  
OPTOELECTRONICS USA, INC.,

*Defendants.*

Civil Action No. 06-726-GMS

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AU OPTRONICS CORPORATION,

*Plaintiff,*

vs.

LG.PHILIPS LCD CO., LTD. and  
LG.PHILIPS LCD AMERICA, INC.,

*Defendants.*

Civil Action No. 07-357-GMS

**CONSOLIDATED CASES**

**JURY TRIAL DEMANDED**

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**AU OPTRONICS CORPORATION'S REPLY TO LG.PHILIPS LCD CO. LTD.'S  
FIRST AMENDED COUNTERCLAIMS AND ADDITIONAL COUNTERCLAIMS  
AGAINST LG.PHILIPS LCD CO. LTD.**

Plaintiff AU OPTRONICS CORPORATION ("AUO") hereby replies to LG.Philips LCD Co., Ltd.'s ("LPL") counterclaims filed on or on about July 24, 2007 (D.I. 103 in C.A. No. 07-357-GMS), asserts affirmative defenses to those claims, and asserts counterclaims against LPL.

**REPLY TO COUNTERCLAIMS**

1. With regard to paragraph 58, AUO denies that LPL is entitled to any relief by virtue of its counterclaims.

2. AUO is without sufficient knowledge or information to form a belief as to the truth of the allegations in paragraph 59 and therefore denies them.

3. With regard to paragraph 60, AUO admits that it is a Taiwanese corporation, and it has a place of business at No. 1, LI-Hsin Road 2, Hsinchu Science Park, Hsinchu Taiwan, R.O.C., and that it manufactures LCD products.

4. AUO is without sufficient knowledge or information to form a belief as to the truth of the allegations in paragraph 61 and therefore denies them.

5. AUO is without sufficient knowledge or information to form a belief as to the truth of the allegations in paragraph 62 and therefore denies them.

6. With regard to paragraph 63, AUO admits that LPL's Counterclaims purport to set forth claims arising under the patent laws of the United States (Title 35 of the United States Code). AUO is without sufficient knowledge or information to form a belief as to the truth of the remaining allegations and therefore denies them.

7. With regard to paragraph 64, AUO admits that LPL's Counterclaims purport to set forth a declaratory judgment claim under 28 U.S.C. §§ 2201 and 2202, and under the patent laws of the United States (Title 35 of the United States Code). AUO is without sufficient knowledge or information to form a belief as to the truth of the remaining allegations and therefore denies them.

8. AUO understands that paragraph 65 references LPL's patent infringement claims, and on that basis, subject matter jurisdiction is proper over LPL's patent infringement claims against AUO under 28 U.S.C. § 1331 and 1338(a).

9. AUO denies the allegations of paragraph 66 that are directed at AUO. As to the remaining allegations in paragraph 66 that are directed at co-defendants in this action, AUO is

without sufficient knowledge or information to form belief as to the truth of such allegations and therefore denies them.

10. AUO is without sufficient knowledge or information to form belief as to the truth the allegations of paragraph 67 and therefore denies them.

11. With regard to paragraph 68, AUO admits that the '569 Patent appears to be entitled "Liquid Crystal Display Device Array Substrate and Method of Manufacturing Same." AUO denies that the '569 Patent was duly and legally issued. AUO is without sufficient knowledge or information to form a belief as to the truth of the remaining allegations and therefore denies them.

12. With regard to paragraph 69, AUO admits that the '984 Patent appears to be entitled "Method and Apparatus for Manufacturing Liquid Crystal Display Device Using Serial Production Processes." AUO denies that the '984 Patent was duly and legally issued. AUO is without sufficient knowledge or information to form a belief as to the truth of the remaining allegations and therefore denies them.

13. With regard to paragraph 70, AUO admits that the '374 Patent appears to be entitled "Liquid Crystal Display Device and Method of Manufacturing the Same." AUO denies that the '374 Patent was duly and legally issued. AUO is without sufficient knowledge or information to form a belief as to the truth of the remaining allegations and therefore denies them.

14. AUO is without sufficient knowledge or information to form a belief as to the truth of the allegations in paragraph 71 and therefore denies them.

15. With regard to paragraph 72, AUO is the owner of all rights, title, and interest in and to the '944, Patent, the '157 Patent and the '506 Patent.

**RESPONSE TO COUNT VI**  
**INFRINGEMENT OF THE '569 PATENT**

- 16. AUO refers to and incorporates herein its responses to paragraphs 58 – 72.
- 17. AUO denies the allegations in paragraph 74.
- 18. AUO denies the allegations in paragraph 75.
- 19. AUO denies the allegations in paragraph 76.
- 20. AUO denies the allegations in paragraph 77.

**RESPONSE TO COUNT VII**  
**INFRINGEMENT OF THE '984 PATENT**

- 21. AUO refers to and incorporates herein its responses to paragraphs 58 – 77.
- 22. AUO denies the allegations in paragraph 79 that are directed at AUO. As to the remaining allegations in paragraph 79 that are directed at co-defendants in this action, AUO is without sufficient knowledge or information to form belief as to the truth of such allegations and therefore denies them.

23. AUO denies the allegations in paragraph 80 that are directed at AUO. As to the remaining allegations in paragraph 80 that are directed at co-defendants in this action, AUO is without sufficient knowledge or information to form belief as to the truth of such allegations and therefore denies them.

24. AUO denies the allegations in paragraph 81 that are directed at AUO. As to the remaining allegations in paragraph 81 that are directed at co-defendants in this action, AUO is without sufficient knowledge or information to form belief as to the truth of such allegations and therefore denies them.

25. AUO denies the allegations in paragraph 82 that are directed at AUO. As to the remaining allegations in paragraph 82 that are directed at co-defendants in this action, AUO is

without sufficient knowledge or information to form belief as to the truth of such allegations and therefore denies them.

**RESPONSE TO COUNT VIII**  
**INFRINGEMENT OF THE '374 PATENT**

26. AUO refers to and incorporates herein its responses to paragraphs 58 – 82.

27. AUO denies the allegations in paragraph 84 that are directed at AUO. As to the remaining allegations in paragraph 84 that are directed at co-defendants in this action, AUO is without sufficient knowledge or information to form belief as to the truth of such allegations and therefore denies them.

28. AUO denies the allegations in paragraph 85 that are directed at AUO. As to the remaining allegations in paragraph 85 that are directed at co-defendants in this action, AUO is without sufficient knowledge or information to form belief as to the truth of such allegations and therefore denies them.

29. AUO denies the allegations in paragraph 86 that are directed at AUO. As to the remaining allegations in paragraph 86 that are directed at co-defendants in this action, AUO is without sufficient knowledge or information to form belief as to the truth of such allegations and therefore denies them.

30. AUO denies the allegations in paragraph 87 that are directed at AUO. As to the remaining allegations in paragraph 87 that are directed at co-defendants in this action, AUO is without sufficient knowledge or information to form belief as to the truth of such allegations and therefore denies them.

**RESPONSE TO COUNTERCLAIM COUNT IX  
CLAIM FOR DECLATORY JUDGMENT OF INVALIDITY OF  
THE '944 PATENT, THE '157 PATENT, AND THE '506 PATENT**

31. AUO hereby refers to and incorporates herein its responses to paragraphs 58 – 87.

32. With regard to paragraph 89, AUO admits that it filed counterclaims for patent infringement in this action and that there is substantial controversy between the parties having adverse legal interests.

33. AUO denies the allegations in paragraph 90.

34. AUO denies the allegations in paragraph 91.

35. AUO denies the allegations in paragraph 92.

36. With regard to paragraph 93, AUO admits that it has asserted the AUO patents against LPL. The remaining allegations are legal assertions to which no answer or response is required.

**RESPONSE TO COUNTERCLAIM COUNT X  
CLAIM FOR DECLATORY JUDGMENT OF NON-INFRINGEMENT OF  
THE '944 PATENT, THE '157 PATENT, AND THE '506 PATENT**

37. AUO hereby refers to and incorporates herein its responses to paragraphs 58 – 93.

38. AUO denies the allegations in paragraph 95.

39. AUO denies the allegations in paragraph 96.

40. AUO denies the allegations in paragraph 97.

41. With regard to paragraph 98, AUO admits that it has asserted the AUO patents against LPL. The remaining allegations are legal assertions to which no answer or response is required.

**RESPONSE TO COUNTERCLAIM COUNT XI**  
**CLAIM FOR DECLATORY JUDGMENT OF**  
**UNENFORCEABILITY OF THE '944 PATENT**

42. AUO hereby refers to and incorporates herein its responses to paragraphs 58 – 94 above.

43. With regard to paragraph 100, AUO admits that the '944 Patent relates to subject matter set forth in the '944 Patent. Because LPL's intended meaning of paragraph 100 is vague, AUO is without sufficient knowledge or information to form a belief as to the truth of the allegations and therefore denies them.

44. AUO is without sufficient knowledge or information to form a belief as to the truth of the allegations in paragraph 101 and therefore denies them.

45. AUO is without sufficient knowledge or information to form a belief as to the truth of the allegations in paragraph 102 and therefore denies them.

46. AUO is without sufficient knowledge or information to form a belief as to the truth of the allegations in paragraph 103 and therefore denies them.

47. AUO is without sufficient knowledge or information to form a belief as to the truth of the allegations in paragraph 104 and therefore denies them.

48. AUO is without sufficient knowledge or information to form a belief as to the truth of the allegations in paragraph 105 and therefore denies them.

49. AUO is without sufficient knowledge or information to form a belief as to the truth of the allegations in paragraph 106 and therefore denies them.

50. AUO is without sufficient knowledge or information to form a belief as to the truth of the allegations in paragraph 107 and therefore denies them.

51. With regard to paragraph 108, AUO admits that a controversy exists between the parties as to the enforceability of the '944 patent. The remaining allegations are legal assertions to which no answer or response is required.

52. AUO denies the allegations in paragraph 109.

### **RESPONSE TO PRAYER FOR RELIEF**

As to paragraphs A through H and O through U of the Prayer for Relief, AUO denies that LPL is entitled to the requested relief. Other paragraphs appear to be directed at third parties, so no response is required.

### **AFFIRMATIVE DEFENSES**

Without conceding that any of the following necessarily must be pleaded as an affirmative defense, or that any of the following are not already at issue by virtue of the foregoing denials, and without prejudice to AUO's right to plead additional defenses as discovery into the facts of the matter warrants, AUO hereby asserts the following affirmative defenses.

#### **First Affirmative Defense**

53. As a First and Separate Affirmative Defense to LPL's Counterclaims, AUO alleges that the Amended Complaint fails to state a claim upon which relief may be granted and fails to set forth facts sufficient to state a claim for relief against AUO.

#### **Second Affirmative Defense**

54. As a Second and Separate Affirmative Defense to LPL's Counterclaims, AUO alleges that its products and processes have not infringed, are not now infringing, and are not

threatening to infringe upon any valid and enforceable claim of the '569 Patent, the '984 Patent and/or the '374 Patent either literally or under the doctrine of equivalents.

**Third Affirmative Defense**

55. As a Third and Separate Affirmative Defense to LPL's Counterclaims, AUO alleges that it has neither directly or indirectly contributed to the infringement of, nor induced another to infringe the '569 Patent, the '984 Patent and/or the '374 Patent.

**Fourth Affirmative Defense**

56. As a Fourth and Separate Affirmative Defense to LPL's Counterclaims, AUO alleges that the '569 Patent, the '984 Patent and/or the '374 Patent are invalid for failure to comply with one, or more, of the requirements of 35 U.S.C. §§ 101, 102, 103, 112, and/or 116.

**Fifth Affirmative Defense**

57. As a Fifth and Separate Affirmative Defense to LPL's Counterclaims, AUO alleges that LPL's claims are barred by the equitable doctrine of laches and/or estoppel.

**Sixth Affirmative Defense**

58. As a Sixth and Separate Affirmative Defense to LPL's Counterclaims, AUO alleges that LPL is precluded from construing such patents to cover AUO's conduct and/or products, and is further estopped from asserting infringement under the doctrine of equivalents, on the basis of the statements made during the prosecution of one or more of the '569 Patent, the '984 Patent and/or the '374 Patent.

**Seventh Affirmative Defense**

59. As a Seventh and Separate Affirmative Defense to LPL's Counterclaims, AUO alleges that Plaintiff's damages are barred and/or limited by the provisions of 35 U.S.C. § 271, 286 and/or 287.

**ADDITIONAL COUNTERCLAIMS AGAINST LG.PHILIPS LCD CO., LTD.**

By these Counterclaims and pursuant to Rules 12 and/or 13 of the Federal Rules of Civil Procedure, Plaintiff/Counterclaimant AU Optronics Corporation ("AUO") seeks injunctive and declaratory relief and damages, including treble or multiple damages, for patent infringement of U.S. Patent No. 7,101,069 ("the '069 Patent"), and U.S. Patent No. 5,748,266 ("the '266 Patent"), (collectively "the AUO Patents") against Defendants LG.Philips LCD Co., Ltd. ("LPL"). AUO also seeks declaratory relief with respect to LPL's patent counterclaims.

**THE COUNTERCLAIM PARTIES**

60. Plaintiff and Counterclaimant AUO is a corporation organized and existing under the laws of the Republic of China (Taiwan), with its principle place of business located in Taiwan.

61. AUO is the owner of the AUO Patents.

62. Defendant LG.Philips LCD Co., Ltd. ("LPL") alleges that it is a corporation organized and existing under the laws of the Republic of Korea, having its principal place of business at Seoul, Korea.

63. Upon information and belief, LPL has committed and continues to commit acts of patent infringement within this judicial district by working in concert to make, use, sell, offer to sell, and/or import LCD modules, products, and systems containing such LCD modules in this judicial district that are covered by the AUO Patents.

64. LPL claims to be the owner by assignment of United States Patent No. 6,664,569 (“the ’569 Patent”), United States Patent 6,803,984 (the ’984 Patent), and United States Patent 7,218,374 (the ’374 Patent) (collectively “the LPL Patents”).

65. These Counterclaims are based upon and arise under the Patent Laws of the United States, 35 U.S.C. § 100, *et seq.*, and in particular §§ 271, 281, 283, 284 and 285.

66. Additionally, these Counterclaims are under the Declaratory Judgment Act, 28 U.S.C. §§ 2201 and 2202, and the Patent Laws of the United States, based upon an actual controversy between LPL and AUO regarding the validity and claims of the ’569 Patent, and is intended to provide appropriate and necessary declaratory relief.

### **JURISDICTION AND VENUE**

67. The Court has jurisdiction over the subject matter of these Counterclaims pursuant to 28 U.S.C. §§ 1331 and 1338(a).

68. This Court has jurisdiction over the Counterclaims for declaratory relief under the Declaratory Judgment Act, 28 U.S.C. §§ 2201 and 2202, under the laws of the United States concerning actions relating to patents, 28 U.S.C. § 1338(a), and under 28 U.S.C. § 1331.

69. This court has personal jurisdiction and venue over LPL because, *inter alia*, LPL submitted itself to the jurisdiction of this Court.

### **Counterclaim Count Seven** **(Infringement of U.S. Patent No. 7,101,069)**

70. On September 5, 2006, the United States Patent and Trademark Office duly and legally issued U.S. Patent No. 7,101,069 entitled “Direct Backlight Module” (the ’069 Patent). AUO is the owner of all rights, title and interest in and to the ’069 Patent. A copy of the ’069 Patent is attached as Exhibit A.

71. On information and belief, LPL has directly infringed, contributorily infringed, and/or actively induced infringement of the '069 Patent by making, using, importing, offering for sale, and/or selling in the United States LCD modules, products, and systems containing such LCD modules covered by one or more claims of the '069 Patent.

72. On information and belief, the infringement of the '069 Patent by LPL has been and continues to be deliberate and willful, and such infringement will continue unless LPL is preliminarily and permanently enjoined by this Court.

73. As a consequence of the infringement of LPL complained herein, AUO has been damaged and will continue to sustain damages by such acts in amount to be determined at trial and will continue to suffer irreparable loss and injury.

**Counterclaim Count Eight**  
**(Infringement of U.S. Patent No. 5,748,266)**

74. On May 5, 1998,, the United States Patent and Trademark Office duly and legally issued U.S. Patent No. 5,748,266 entitled "Color Filter, Liquid Crystal Display Panel, Liquid Crystal Display, And Liquid Crystal Display Panel Manufacturing Method" (the '266 Patent). AUO is the owner of all rights, title and interest in and to the '266 Patent. A copy of the '266 Patent is attached as Exhibit B.

75. On information and belief, LPL has directly infringed, contributorily infringed, and/or actively induced infringement of the '266 Patent by making, using, importing, offering for sale, and/or selling in the United States LCD modules, products, and systems containing such LCD modules covered by one or more claims of the '266 Patent.

76. On information and belief, the infringement of the '266 Patent by LPL has been and continues to be deliberate and willful, and such infringement will continue unless LPL is preliminarily and permanently enjoined by this Court.

77. As a consequence of the infringement of LPL complained herein, AUO has been damaged and will continue to sustain damages by such acts in amount to be determined at trial and will continue to suffer irreparable loss and injury.

**Counterclaim Count Nine**  
**(Declaratory Judgment of Invalidity of the**  
**'569 Patent, the '984 Patent and/or the '374 Patent)**

78. AUO hereby incorporates paragraphs 60 - 77 above as though fully set forth herein.

79. LPL has accused AUO of infringing the LPL Patents by filing its counterclaims in this action. As such, there is substantial controversy between the parties having adverse legal interests.

80. Claims of the '569 Patent are invalid for failure to satisfy one or more of the requirements for patentability set forth in Title 35 of the United States Code.

81. Claims of the '984 Patent are invalid for failure to satisfy one or more of the requirements for patentability set forth in Title 35 of the United States Code.

82. Claims of the '374 Patent are invalid for failure to satisfy one or more of the requirements for patentability set forth in Title 35 of the United States Code.

83. Because LPL has asserted the LPL Patents against AUO, thereby creating an actual controversy, declaratory relief is both appropriate and necessary to establish that one or more of the claims of the '569 Patent, the '984 Patent and/or the '374 Patent are invalid.

**Counterclaim Count Ten**  
**(Declaratory Judgment of Non-Infringement of the**  
**'569 Patent, the '984 Patent and/or the '374 Patent)**

84. AUO hereby incorporates paragraphs 60 – 83 above as though fully set forth herein.

85. AUO has not infringed and does not infringe any claim of the '569 Patent, either literally or under the doctrine of equivalents.

86. AUO has not infringed and does not infringe any claim of the '984 Patent, either literally or under the doctrine of equivalents.

87. AUO has not infringed and does not infringe any claim of the '374 Patent, either literally or under the doctrine of equivalents.

88. Because LPL maintains that AUO infringes the LPL Patents, thereby creating an actual controversy, a declaration of rights between LPL and AUO is both appropriate and necessary to establish that LPL has not infringed and does not infringe any claim of the '569 Patent, the '984 Patent and/or the '374 Patent.

#### **EXCEPTIONAL CASE**

89. This is an exceptional case under 35 U.S.C. § 285 and, as such, Plaintiff/Counterclaimant AUO is entitled to recover from LPL the attorneys' fees and costs incurred in connection with this action.

#### **PRAYER FOR RELIEF**

**WHEREFORE**, AUO respectfully requests that the Court:

- A. Dismiss LPL's Counterclaims with prejudice;
- B. Enter judgment in favor of AUO and declare that each of the claims of the '569 Patent are invalid;
- C. Enter judgment in favor of AUO and declare that each of the claims of the '984 Patent are invalid;
- D. Enter judgment in favor of AUO and declare that each of the claims of the '374 Patent are invalid;

E. Enter judgment in favor of AUO and declare that AUO has not infringed any claim of the '569 Patent either literally or under the doctrine of equivalents;

F. Enter judgment in favor of AUO and declare that AUO has not infringed any claim of the '984 Patent either literally or under the doctrine of equivalents;

G. Enter judgment in favor of AUO and declare that AUO has not infringed any claim of the '374 Patent either literally or under the doctrine of equivalents;

H. Enter judgment in favor of AUO and declare that the '069 Patent is valid and enforceable;

I. Enter judgment in favor of AUO and declare that the '266 Patent is valid and enforceable;

J. Enter judgment in favor of AUO and declare that LPL has infringed, actively induced infringement of, and contributorily infringed '069 Patent and the '266 Patent;

K. Preliminarily and permanently enjoin LPL from further infringement of '069 Patent and the '266 Patent, by unauthorized use of the inventions patented therein, by LPL and its officers agents, servants, employees, attorneys and all persons in active concert or participation with them;

L. Award damages and prejudgment interest to AUO for the infringement of '069 Patent and the '266 Patent;

M. Declare that the infringement of '069 Patent and the '266 Patent by LPL is willful, and award treble damages to AUO as provided by 35 U.S.C. § 284;

N. Declare that this is an exceptional case under 35 U.S.C. § 285 and award to AUO its attorneys' fees and costs; and

O. Grant such other and further relief as the Court may deem just and proper.

**DEMAND FOR JURY TRIAL**

Pursuant to Rule 38(b) of the Federal Rules of Civil Procedure, AU OPTRONICS CORPORATION respectfully demands a trial by jury on all issues so triable in this action.

August 22, 2007

**YOUNG CONAWAY STARGATT & TAYLOR LLP**  
*/s/ Karen L. Pascale*

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**CERTIFICATE OF SERVICE**

I, Karen L. Pascale, Esquire, hereby certify that on August 22, 2007, I caused to be electronically filed a true and correct copy of the foregoing document with the Clerk of the Court using CM/ECF, which will send notification that such filing is available for viewing and downloading to the following counsel of record:

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I further certify that I caused a copy of the foregoing document to be served by e-mail and hand delivery on the above-listed counsel of record and on the following non-registered participants in the manner indicated:

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August 22, 2007

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# Exhibit A



US007101069B2

(12) **United States Patent**  
Yu et al.

(10) **Patent No.:** US 7,101,069 B2

(45) **Date of Patent:** Sep. 5, 2006

(54) **DIRECT BACKLIGHT MODULE**

(75) **Inventors:** Chuan-Pei Yu, Ilan (TW); Ilan-Chou Liu, Hsinchu (TW); Chin-Kun Hsieh, Hsinchu (TW)

(73) **Assignee:** Au Optonics Corp., Hsinchu (TW)

(\*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 219 days.

(21) **Appl. No.:** 10/613,493

(22) **Filed:** Jul. 2, 2003

(65) **Prior Publication Data**

US 2004/0012763 A1 Jan. 22, 2004

(30) **Foreign Application Priority Data**

Jul. 19, 2002 (TW) ..... 91116115 A

(51) **Int. Cl.**  
F21V 7/00 (2006.01)  
F21V 21/00 (2006.01)

(52) **U.S. Cl.** ..... 362/558; 362/560; 362/225; 362/260; 362/581

(58) **Field of Classification Search** ..... 362/558, 362/560, 224, 225, 339, 249, 260, 581, 614, 362/634

See application file for complete search history.

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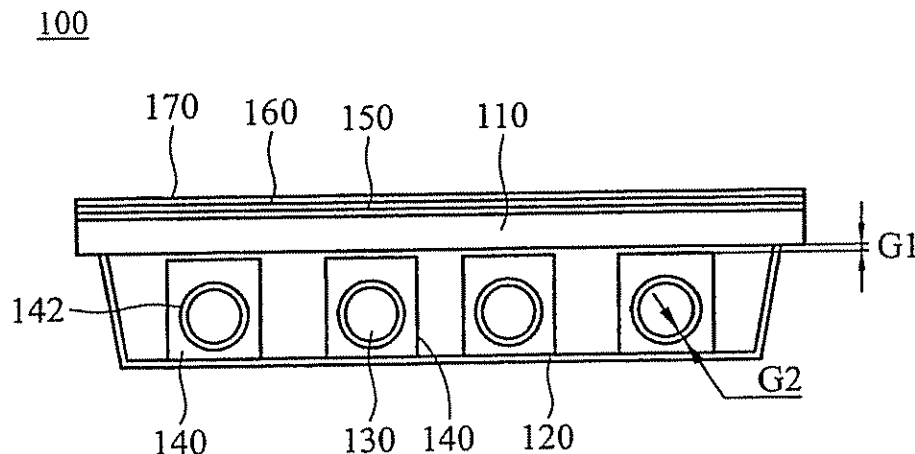
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#### (57) ABSTRACT

A direct backlight module. The direct backlight module includes a diffuser, a reflecting plate, an illumination tube and a support. The reflecting plate is disposed under the diffuser. The illumination tube is disposed between the diffuser and the reflecting plate. The support is disposed on the reflecting plate and between the diffuser and the reflecting plate. In addition, the support has a fitting portion into which the illumination tube directly fits. The support supports the diffuser and the illumination tube simultaneously.

18 Claims, 6 Drawing Sheets



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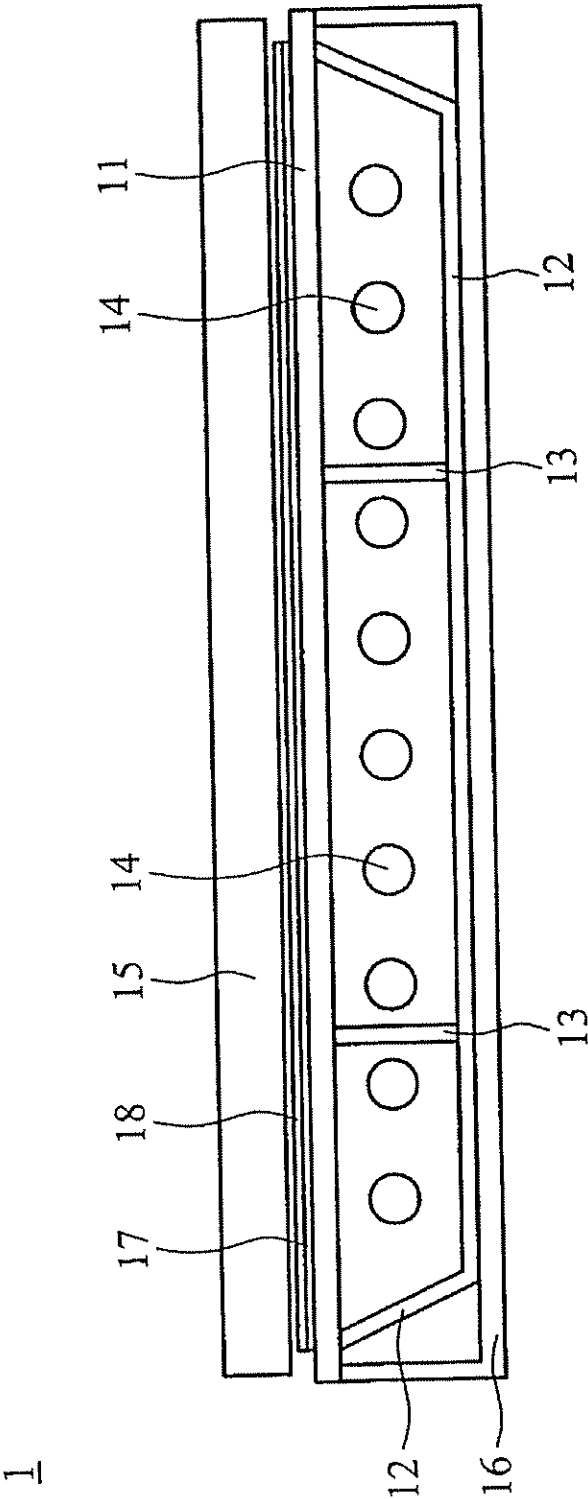


FIG. 1 (PRIOR ART)

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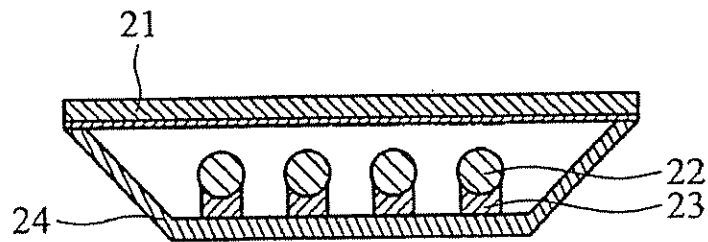


FIG. 2 (PRIOR ART)

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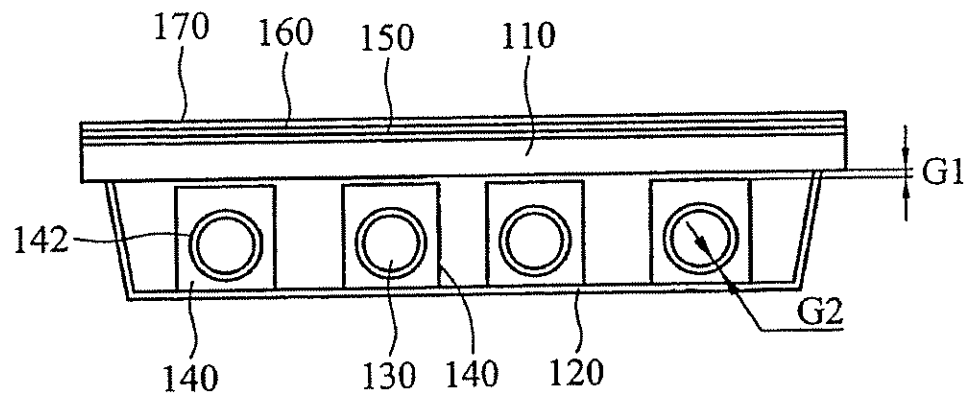


FIG. 3

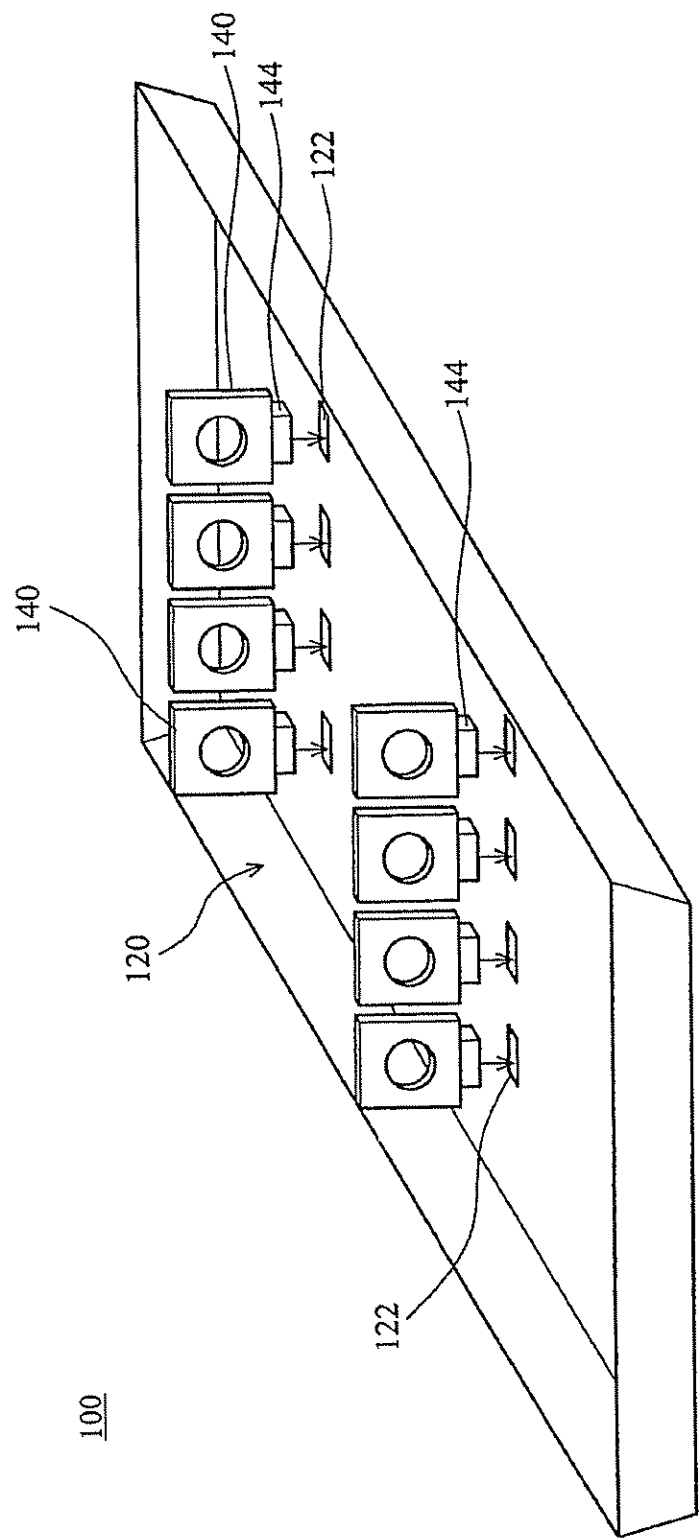


FIG. 4

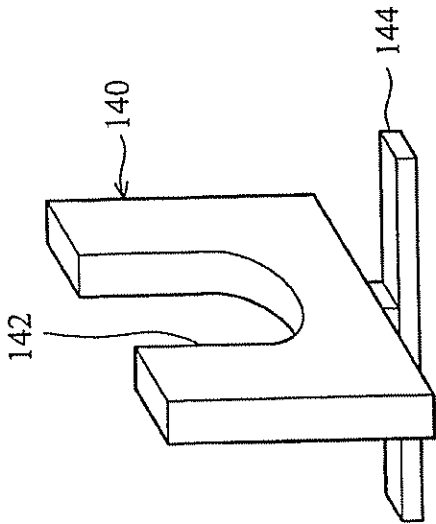


FIG. 5C

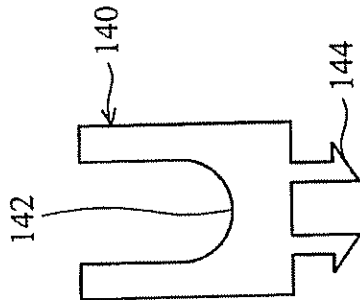


FIG. 5B

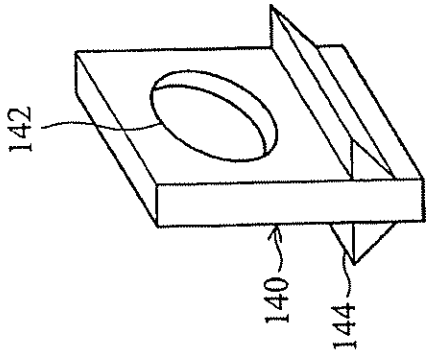


FIG. 5A

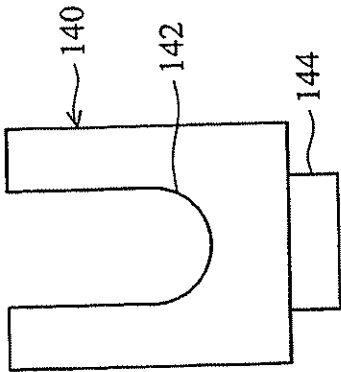


FIG. 5F

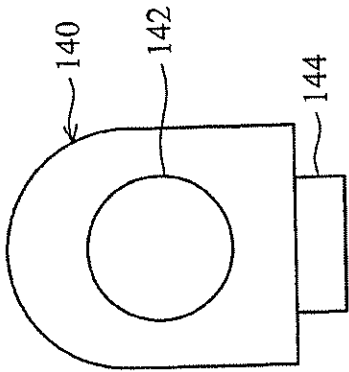


FIG. 5E

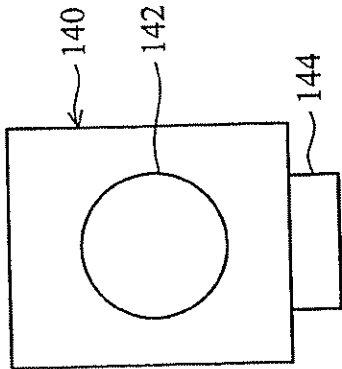


FIG. 5D

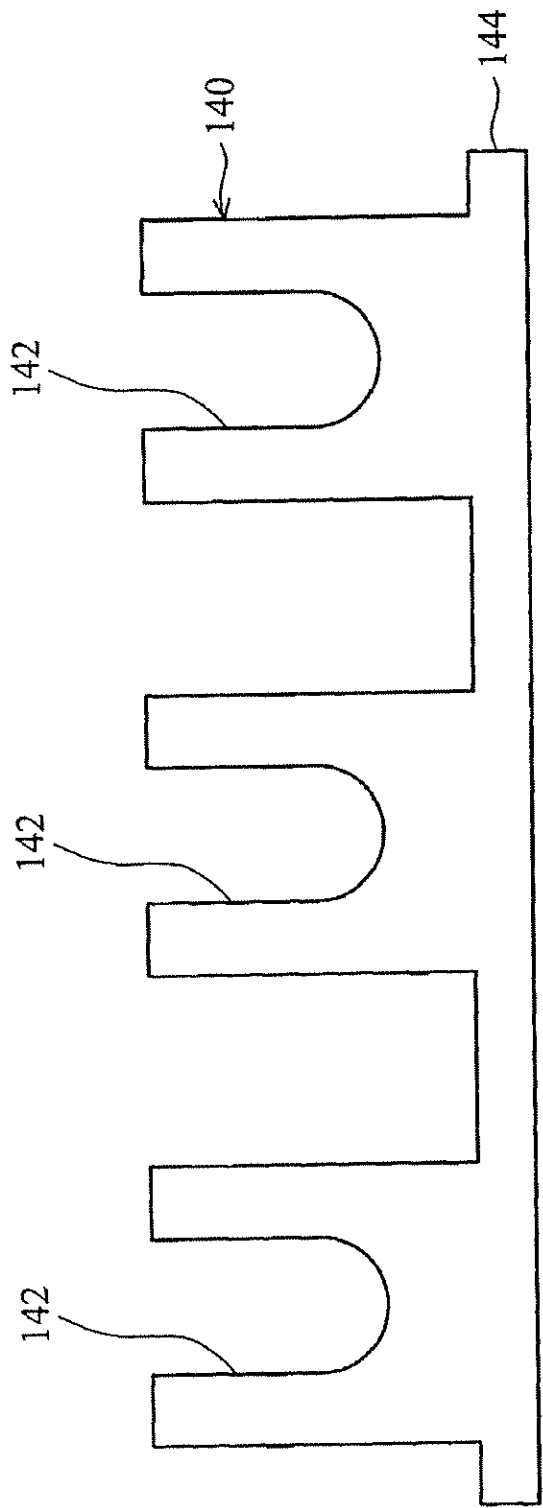


FIG. 5G

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## DIRECT BACKLIGHT MODULE

## BACKGROUND OF THE INVENTION

## 1. Field of the Invention

The present invention relates to a direct backlight module, and in particular to a direct backlight module supporting the diffuser and illumination tubes simultaneously to overcome bending of the diffuser and illumination tubes due to thermal expansion and contraction and insufficient rigidity thereof.

## 2. Description of the Related Art

FIG. 1 is a cross section showing a conventional direct backlight module 1. The conventional direct backlight module 1 includes a diffuser 11, a reflecting plate 12, a prism 17, a diffusing plate 18, two supports 13 and a plurality of illumination tubes 14. The reflecting plate 12 is disposed under the diffuser 11. The prism 17 is disposed on the diffuser 11. The diffusing plate 18 is disposed on the prism 17. The supports 13 are disposed on the reflecting plate 12 and located between the diffuser 11 and the reflecting plate 12. The plural illumination tubes 14 are disposed between the diffuser 11 and the reflecting plate 12.

As shown in FIG. 1, in order to protect the diffuser 11 from bending, the supports 13 are disposed between the diffuser 11 and the reflecting plate 12 to support the diffuser 11. Thus, the optical character of the direct backlight module 1 is not deteriorated and even the illumination tubes 14 are not damaged by the bent diffuser 11. Nevertheless, when the size of the LCD panel 15 increases, the illumination tube 14 also becomes larger. Thus, the illumination tube 14 is bent and deformed due to its weight, deteriorating the optical character of the direct backlight module 1.

FIG. 2 is a cross section showing another conventional direct backlight module 2. In order to overcome the aforementioned deformation of the illumination tubes 14 of the direct backlight module 1, a support 23 is disposed under the illumination tube 22 of the direct backlight module 2. Nevertheless, as shown in FIG. 2, when the size of the LCD panel (not shown) increases, the diffuser 21 also becomes large. Thus, the diffuser 21 is bent and deformed, deteriorating the optical character of the direct backlight module 2.

Consequently, the invention provides a direct backlight module supporting the diffuser and the illumination tubes simultaneously. The diffuser and illumination tubes are not bent and deformed due to insufficient rigidity thereof even when the LCD panel or the diffuser is large. Further, the diffuser and the illumination tubes are not deformed due to thermal expansion and contraction even when the direct backlight module works for a long period of time. Thus, the optical character of the direct backlight module is not deteriorated.

## SUMMARY OF THE INVENTION

An object of the invention is to provide a direct backlight module. The direct backlight module comprises a diffuser; a reflecting plate disposed under the diffuser; an illumination tube disposed between the diffuser and the reflecting plate; and a support disposed on the reflecting plate and between the diffuser and the reflecting plate for supporting the diffuser and the illumination tube simultaneously, wherein the support has a fitting portion into which the illumination tube directly fits.

A detailed description will be given by the following embodiments with reference to the accompanying drawings.

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## BRIEF DESCRIPTION OF THE DRAWINGS

The present invention can be more fully understood by reading the subsequent detailed description and examples with references made to the accompanying drawings, wherein:

FIG. 1 is a cross section showing a conventional direct backlight module;

FIG. 2 is a cross section showing another conventional direct backlight module;

FIG. 3 is a cross section showing the direct backlight module of the invention;

FIG. 4 is a schematic view showing the supports disposed in the direct backlight module of the invention;

FIGS. 5A, 5B, 5C, 5D, 5E, 5F and 5G show the configurations of the present supports.

## DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 3 and FIG. 4, the direct backlight module 100 comprises a diffuser 110, a reflecting plate 120, an illumination tube 130, a support 140, a first diffusing plate 150, a prism 160 and a second diffusing plate 170.

The first diffusing plate 150, the prism 160 and the second diffusing plate 170 can be added or omitted as required. In addition, the arrangement of the first diffusing plate 150, the prism 160 and the second diffusing plate 170 can be changed as required. In this embodiment, the first diffusing plate 150 is disposed on the diffuser 110. The prism 160 is disposed on the first diffusing plate 150. The second diffusing plate 170 is disposed on the prism 160. The reflecting plate 120 is disposed under the diffuser 110 and the illumination tube 130. The illumination tube 130 is disposed between the diffuser 110 and the reflecting plate 120. The support 140 is disposed on the reflecting plate 120 and between the diffuser 110 and the reflecting plate 120.

As shown in FIG. 3 and FIG. 4, the support 140 supports the diffuser 110 and the illumination tube 130 simultaneously. Additionally, the support 140 has a fitting portion 142 into which the illumination tube 130 directly fits. Thus, the illumination tube 130 is supported by the support 140.

Specifically, a first minor gap G1 exists between the support 140 and the diffuser 110 to protect the diffuser 110 from deformation due to thermal expansion and contraction of the support 140. Nevertheless, the diffuser 110 is in direct contact with the support 140 and supported thereby under normal conditions.

Similarly, a second minor gap G2 exists between the fitting portion 142 of the support 140 and the illumination tube 130 to protect the illumination tube 130 from deformation due to thermal expansion and contraction of the support 140.

In this embodiment, the support 140 is disposed on the reflecting plate 120 and has a rectangular shape. The height of the support 140 is substantially equal to the distance between the diffuser 110 and the reflecting plate 120. The support 140 supports the diffuser 110. Further, the first minor gap G1 between the support 140 and the diffuser 110 protects the diffuser 110 from deformation due to thermal expansion and contraction of the support 140. In addition, the fitting portion 142 is a circular hole for accommodating the illumination tube 130. The diameter of the fitting portion 142 is substantially equal to that of the illumination tube 130. Further, the second minor gap G2 between the fitting portion 142 of the support 140 and the illumination tube 130

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protects the illumination tube 130 from deformation due to thermal expansion and contraction of the support 140.

Additionally, the reflecting plate 120 has a groove 122 and the support 140 has an engaging portion 144 formed thereunder, as shown in FIG. 4. The support 140 is fixed onto the reflecting plate 120 by inserting the engaging portion 144 into the groove 122. Then, the engaging portion 144 is securely fixed in the groove 122 by hot glue.

The support 140, the fitting portion 142 and the engaging portion 144 of the invention can have many configurations, and the shape of the groove 122 of the reflecting plate 120 can be changed according to the shape of the engaging portion 144 of the support 140, as shown in FIGS. 5A, 5B, 5C, 5D, 5E, 5F and 5G.

Moreover, the support 140 is made of a material of light weight and high intensity. For example, the support 140 may be made of plastic such as acrylic. Thus, the total weight of the direct backlight module 100 is not significantly increased. While the invention has been described by way of example and in terms of the preferred embodiment, it is to be understood that the invention is not limited to the disclosed embodiments. To the contrary, it is intended to cover various modifications and similar arrangements (as would be apparent to those skilled in the art). Therefore, the scope of the appended claims should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.

What is claimed is:

1. A direct backlight module, comprising:
  - a diffuser;
  - a reflecting plate disposed under the diffuser;
  - an illumination tube disposed between the diffuser and the reflecting plate; and
  - a support disposed between the diffuser and the reflecting plate, the support having a fitting portion, wherein:
    - the fitting portion comprises two side walls extending upwardly and separately,
    - the illumination tube is disposed in the fitting portion and between the side walls, and
    - at least one of the side walls extends toward and beyond the top of the illumination tube for preventing bending of the diffuser.
2. The direct backlight module as claimed in claim 1, wherein a first gap exists between the support and the diffuser to protect the diffuser from deformation due to thermal expansion of the support.
3. The direct backlight module as claimed in claim 1, wherein a second gap exists between the fitting portion of the support and the illumination tube to protect the illumination tube from deformation due to thermal expansion of the support.

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4. The direct backlight module as claimed in claim 1, wherein the reflecting plate further comprises a groove and the support further comprises an engaging portion engaged in the groove.

5. The direct backlight module as claimed in claim 1, wherein the support is fixed to the reflecting plate by glue.

6. The direct backlight module as claimed in claim 5, wherein the support is fixed to the reflecting plate by hot glue.

7. The direct backlight module as claimed in claim 1, wherein the fitting portion of the support is a circular hole.

8. The direct backlight module as claimed in claim 1, wherein the fitting portion of the support is a U-shaped recess.

9. The direct backlight module as claimed in claim 1, wherein the support has a substantially rectangular shape.

10. The direct backlight module as claimed in claim 1, wherein the support has a substantially polygonal shape.

11. The direct backlight module as claimed in claim 1, wherein the support has a substantially curved shape.

12. The direct backlight module as claimed in claim 1, wherein the support is made of plastic.

13. The direct backlight module as claimed in claim 1, further comprising a diffusing plate disposed on the diffuser.

14. The direct backlight module as claimed in claim 1, further comprising a prism disposed on the diffuser.

15. The direct backlight module as claimed in claim 13, further comprising a prism disposed on the diffusing plate.

16. A direct backlight module, comprising:
 

- a diffuser;
- a reflecting plate disposed under the diffuser;
- an illumination tube disposed between the diffuser and the reflecting plate; and

a support disposed between the diffuser and the reflecting plate, the support having a fitting portion, wherein:
 

- the fitting portion has two side walls extending upwardly and separately,
- the illumination tube is disposed in the fitting portion and between the side walls, and
- at least one of the side walls extends toward and beyond the top of the illumination tube for preventing bending of the diffuser.

17. The direct backlight module as claimed in claim 1, wherein the side walls are connected to each other after extending beyond the top of the illumination tube.

18. The direct backlight module as claimed in claim 16, wherein the side walls are connected to each other after extending beyond the top of the illumination tube.

\* \* \* \* \*

# Exhibit B



US005748266A

**United States Patent** [19]**Kodate**[11] **Patent Number:** **5,748,266**[45] **Date of Patent:** **May 5, 1998**

[54] **COLOR FILTER, LIQUID CRYSTAL DISPLAY PANEL, LIQUID CRYSTAL DISPLAY, AND LIQUID CRYSTAL DISPLAY PANEL MANUFACTURING METHOD**

[75] **Inventor:** **Manabu Kodate**, Yokohama, Japan

[73] **Assignee:** **International Business Machines Corporation**, Armonk, N.Y.

[21] **Appl. No.:** **615,012**

[22] **Filed:** **Mar. 11, 1996**

[30] **Foreign Application Priority Data**

Mar. 10, 1995 [JP] Japan ..... 7-050749

[51] **Int. Cl.** ..... **G02F 1/1339; G02F 1/1343**

[52] **U.S. Cl.** ..... **349/39; 349/106; 349/110; 349/139; 349/155; 349/187**

[58] **Field of Search** ..... **349/38, 39, 106, 349/155, 139, 156, 143, 110, 187; 430/20, 7; 359/891; 345/88**

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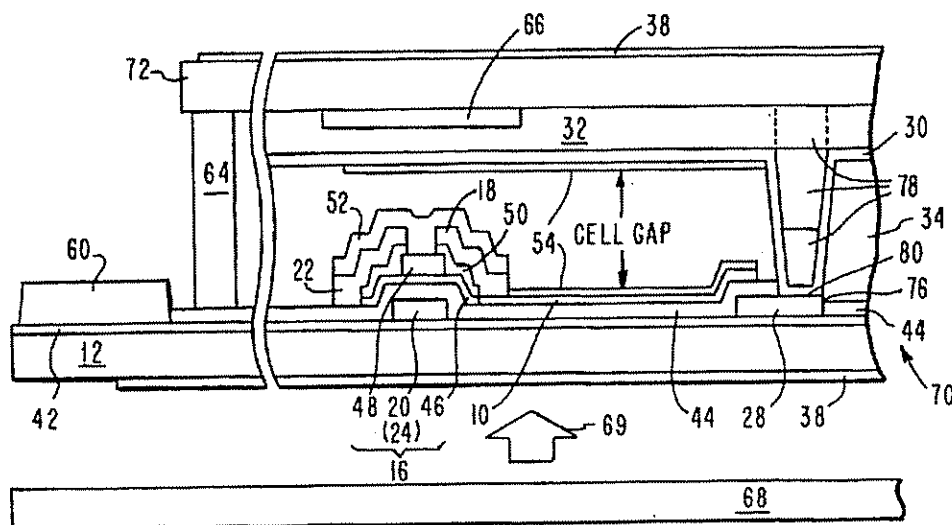
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*Primary Examiner*—William L. Sikes  
*Assistant Examiner*—Tai V. Duong  
*Attorney, Agent, or Firm*—Ronald L. Drumheller

[57] **ABSTRACT**

To prevent a signal delay of an active-matrix liquid crystal display from occurring in an active-matrix liquid crystal display having an active element for each pixel electrode, a potential is supplied to a common electrode from a storage capacitance line by forming a pillar of a color filter to specify a cell gap between an array substrate having the storage capacitance line and a facing substrate having the color filter and electrically connecting the common electrode covering the pillar of the color filter with the storage capacitance line on the array substrate. Thereby, it is possible to disuse a transfer dotting process which is a factor of decreasing the yield and also a factor of decreasing the effective display area. Moreover, because the potential is supplied to the common electrode from the storage capacitance line, it is possible to prevent a signal delay of the common electrode from occurring and moreover realize a high-image-quality screen even in a large and high-definition liquid crystal display without causing irregularity of a display screen or decrease of a contrast ratio. Furthermore, because it is possible to disuse a spacer scattering process and specify a cell gap by securing the pillar of the color filter, not only the cell gap is kept constant at any place and the uniformity of the screen is maintained but also spacers do not brighten or the screen is not blackened due to coagulation of the spacers and the image quality is improved. Furthermore, the cost can be decreased because the transfer dotting process and the spacer scattering process are unnecessary.

**10 Claims, 7 Drawing Sheets**



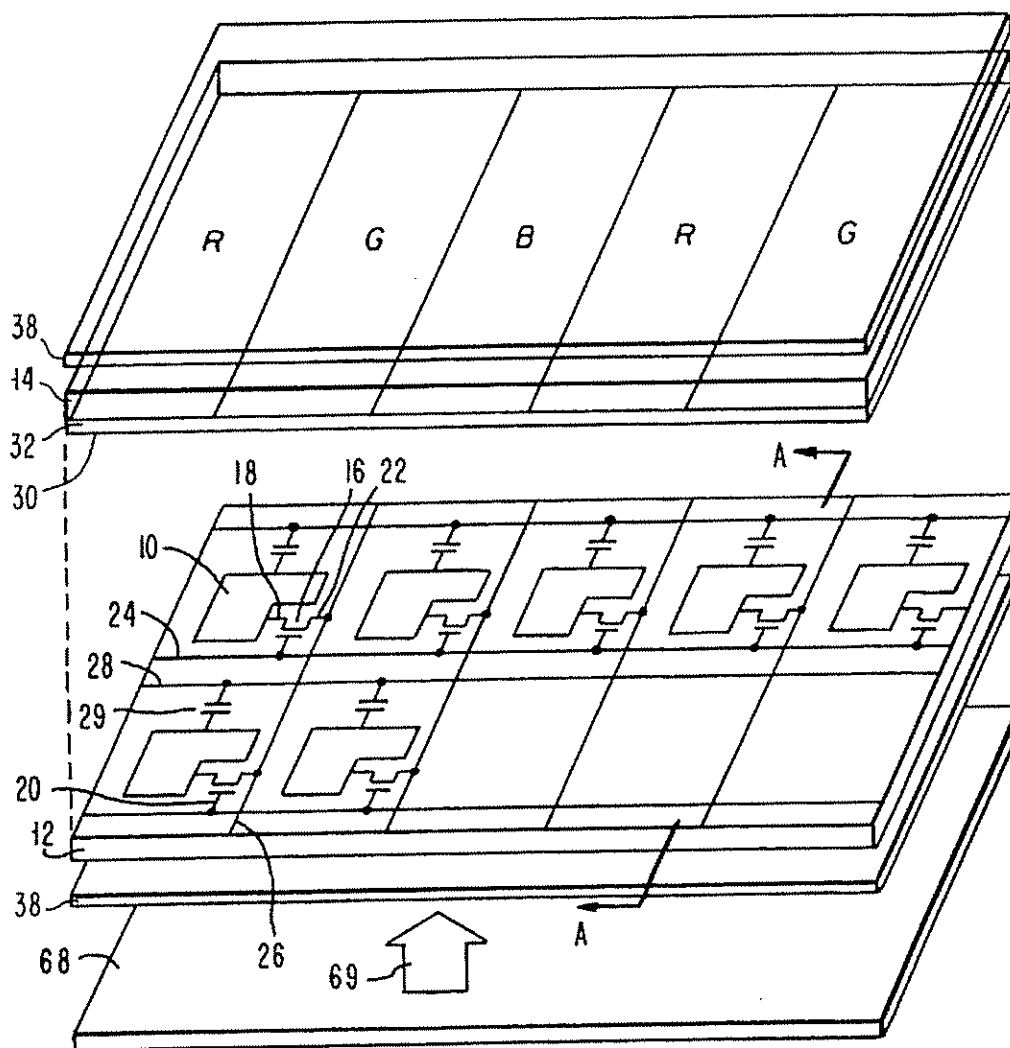
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FIG. 1  
PRIOR ART

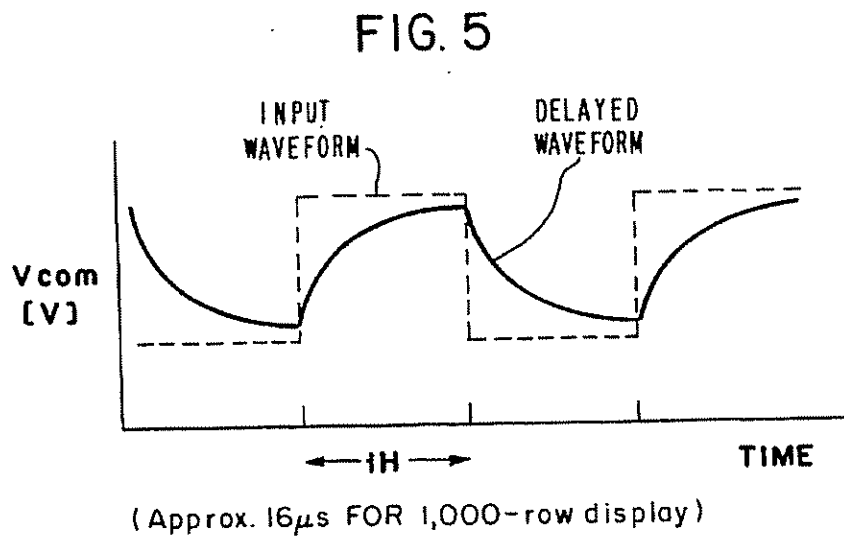
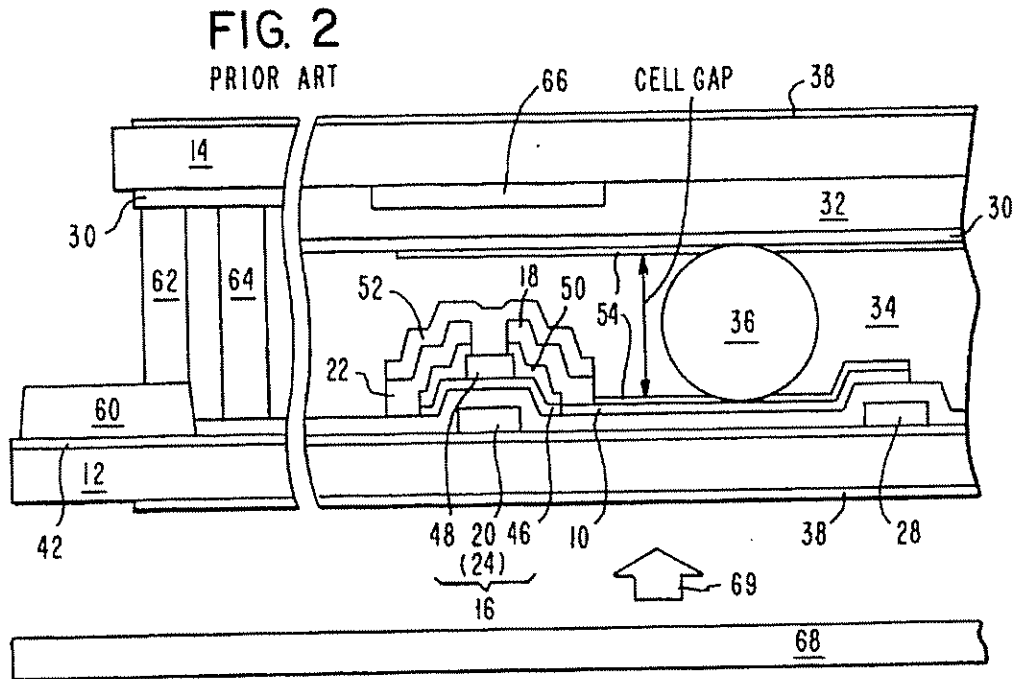


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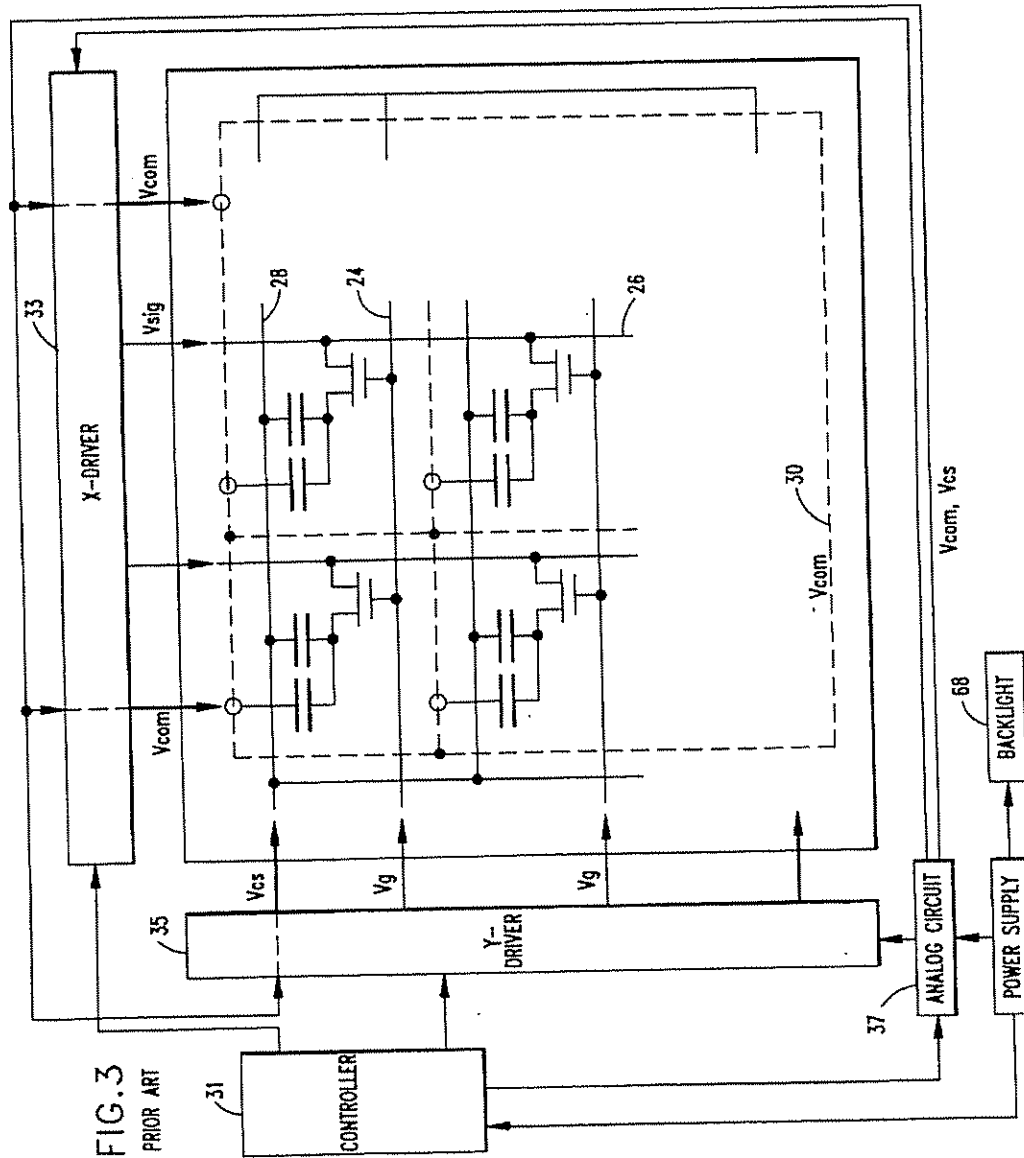


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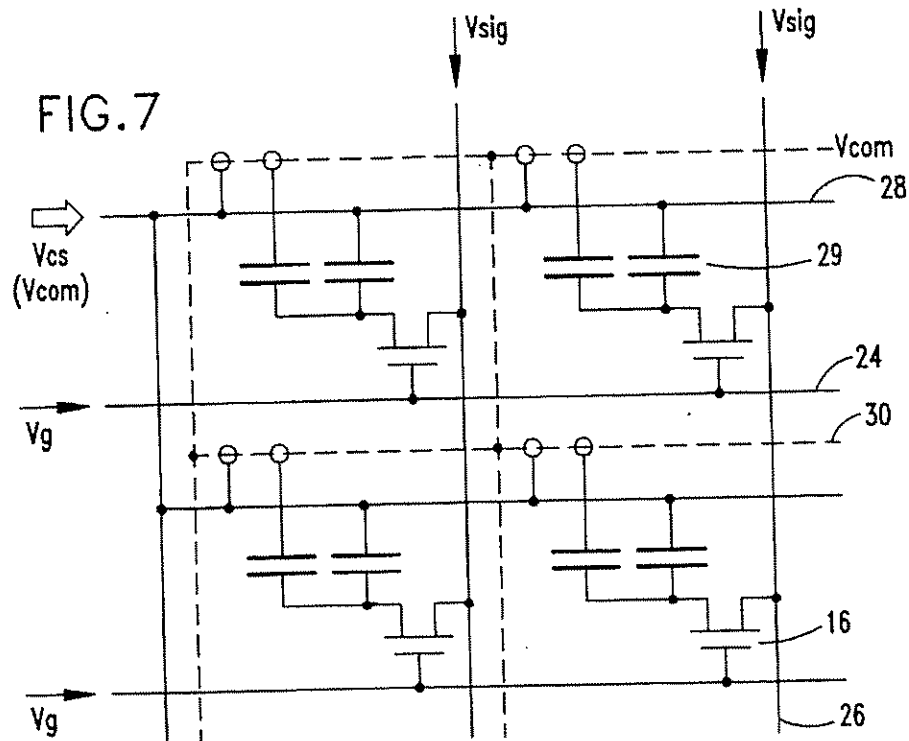
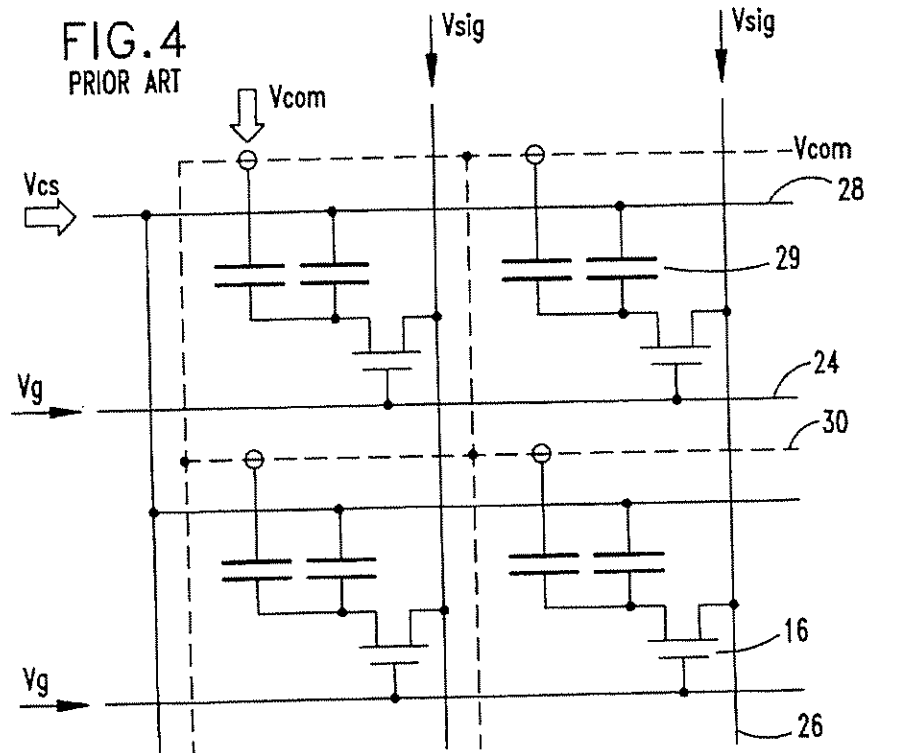


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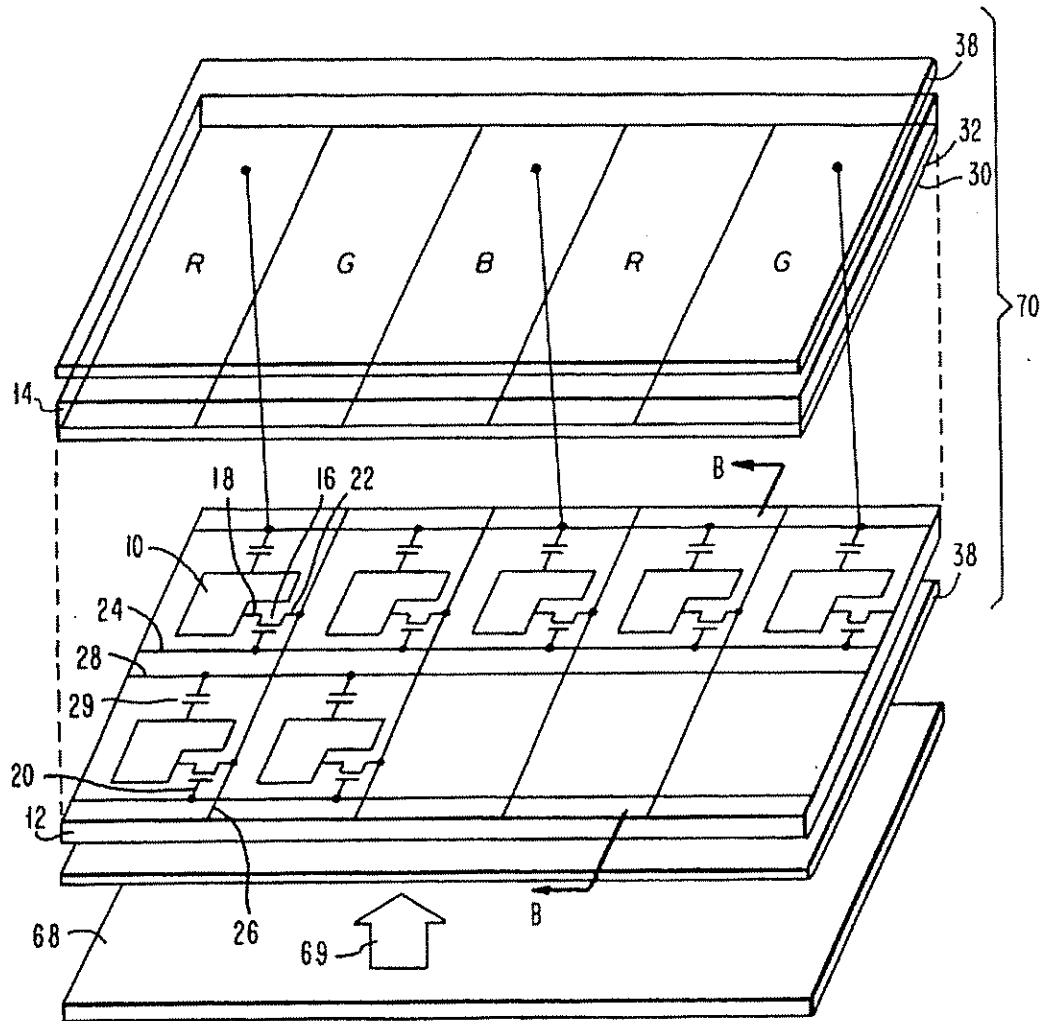
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FIG. 6



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FIG. 8

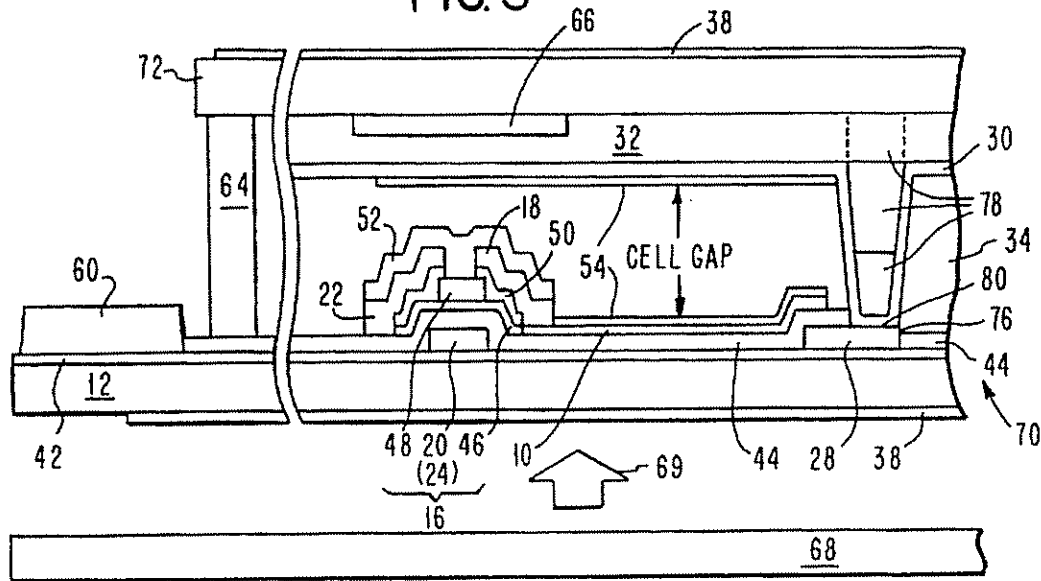
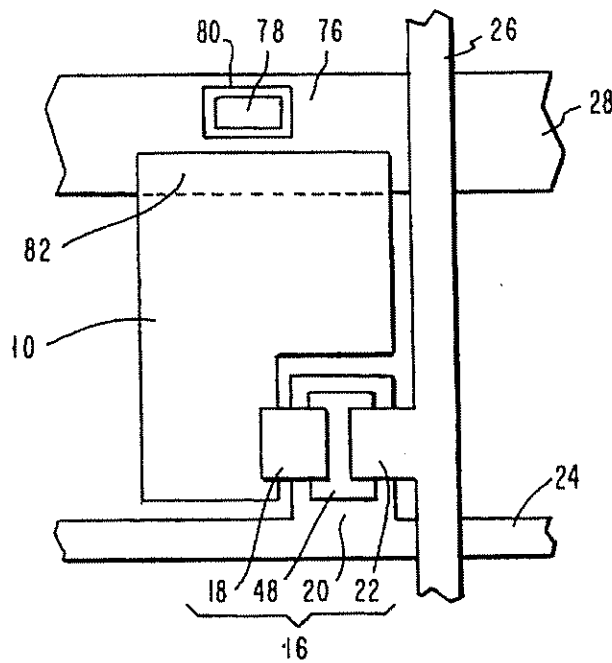


FIG. 9



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FIG. 10

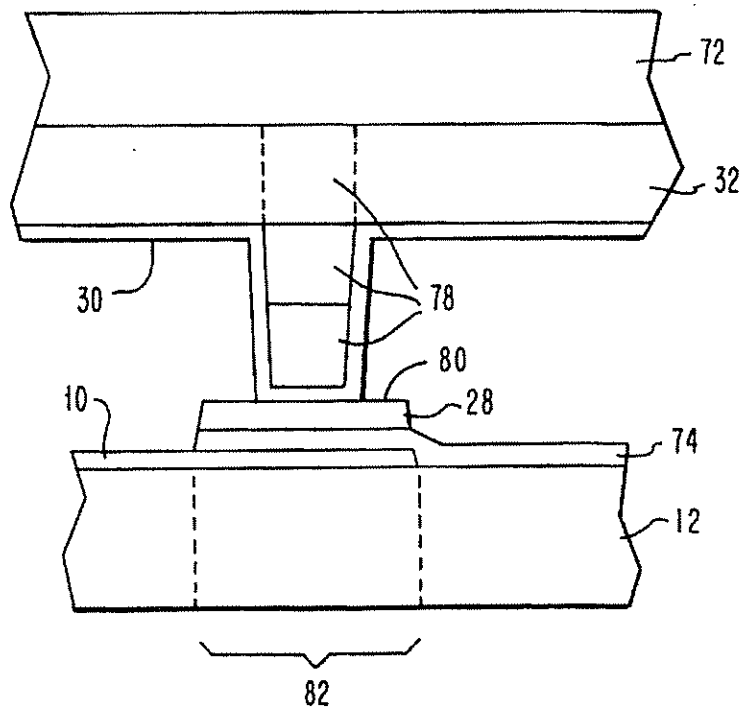
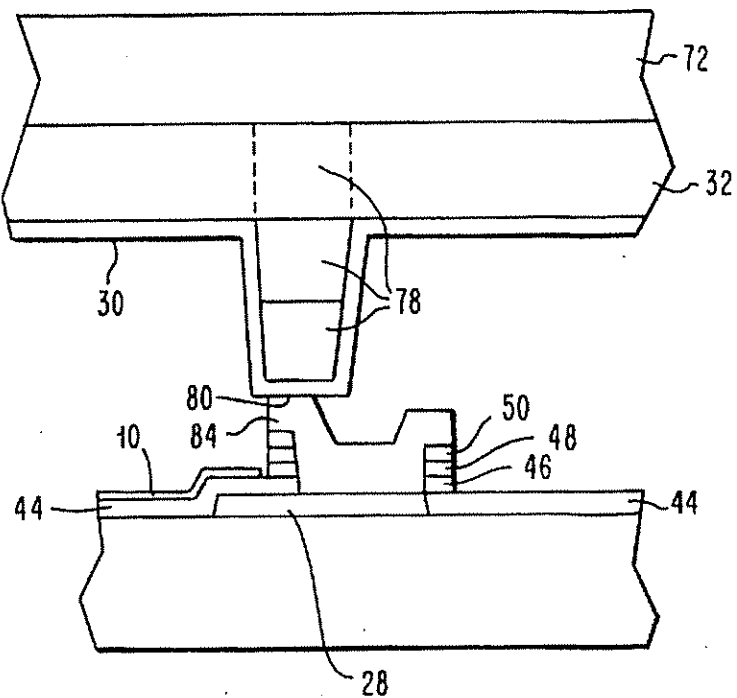


FIG. 11



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# COLOR FILTER, LIQUID CRYSTAL DISPLAY PANEL, LIQUID CRYSTAL DISPLAY, AND LIQUID CRYSTAL DISPLAY PANEL MANUFACTURING METHOD

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

The present invention relates to an active-matrix liquid crystal display. More particularly, the present invention relates to a thin-film-transistor liquid crystal display (TFT-LCD) having a storage capacitance line on an array substrate.

### 2. Related Art

A liquid crystal display (LCD) has been noticed in recent years as a display unit substituted for a CRT (Cathode Ray Tube) which is an existing display unit. This is first because the LCD has an advantage that the occupying area of it is smaller than that of the CRT since the LCD is a flat display unit. Therefore, the LCD makes it possible to decrease office spaces and the demand for the LCD is increased on and on as portable display and household displays become popular.

Moreover, the LCD has an advantage that the power consumption is less than that of the CRT. Therefore, the LCD realizes a compact lightweight display provided with a small battery. In particular, an active-matrix liquid crystal display mounting an active element for each picture element of a liquid crystal display panel is noticed because it provides a display quality equal to that of the CRT.

FIGS. 1 and 2 are a typical schematic and a sectional view showing the structure of an existing TFT-LCD. First, the structure of the existing TFT-LCD is described below by referring to FIG. 1. The TFT-LCD comprises an array substrate 12 on which pixel electrodes 10 are formed like a matrix and a facing substrate 14 arranged so as to face the array substrate surface at a predetermined interval. A TFT 16 serving as a switching element is formed near the pixel electrodes 10 on the array substrate 12 of the TFT-LCD respectively and source electrodes 18 of these TFTs are connected to the pixel electrodes 10. A gate electrode 20 and a drain electrode 22 of a TFT are connected to the gate line 24 and data line 26 constituting a row and a column of a matrix respectively. The gate lines 24 and the data lines 26 are formed at predetermined intervals and they are all perpendicular to each other. Moreover, each pixel electrode 10 has a necessary capacitance between the pixel electrode 10 and the storage capacitance line 28. This capacitance serves as a storage capacitance 29.

As shown in FIG. 2, an existing TFT-LCD has a structure in which an undercoat layer 42, a gate electrode 20 (gate line 24), a pixel electrode 10, a gate insulating film 44, a semiconductor layer (channel layer) 46, a channel protective film 48, an ohmic contact layer 50, a passivation film 52, and an alignment film 54 are deposited on an array substrate 12. Among these layers and films, the undercoat layer 42, channel protective layer 48, passivation film 52, and alignment film 54 may not be deposited. A common electrode 30 is formed at the facing substrate 14 side of the TFT-LCD correspondingly to an area in which pixel electrodes 10 on the array substrate 12 are arranged like a matrix. Input signals are supplied to an OLB (Outer Lead Bonding) electrode 60 extended from a pixel area in which the pixel electrode 10 on the array substrate 12 is formed up to the perimeter of the area. Among the potentials of these signals, the potential of the common electrode 30 on the facing substrate is supplied from a plurality of portions of electrodes on the array substrate through a transfer 62 using

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conductive paste at the outside of the pixel area. The common electrode 30 is made of a transparent material such as ITO (Indium Tin Oxide) because it is necessary to pass light through the electrode 30. However, because the material has a large electric resistance, the electric resistance from a potential supply terminal to the central portion of a display screen increases as a display unit increases in size. Moreover, in the case of a color-display TFT-LCD, a color filter 32 consisting of three primary colors of red (R), green (G), and blue (B) is formed like a matrix between the facing substrate 14 and the common electrode 30 correspondingly to the pixel electrode 10 of the array substrate 12. Furthermore, a black matrix 66 is formed like a lattice. In the case of an existing liquid crystal display, transparent spherical spacers 36 are scattered in a liquid crystal layer 34 held by the array substrate 12 and the facing substrate 14 in order to keep a predetermined interval between the two substrates 12 and 14. Moreover, liquid crystal is sealed between the two substrates by a sealant 64. Furthermore, a polarizing film 38 is frequently set at the outer laterals of the array substrate 12 and the facing substrate 14. Furthermore, a direct-view transmission-type TFT-LCD has a backlight 68 and an image is outputted by controlling the transmittance of an incident light 69 emitted from the backlight 68.

FIGS. 3 and 4 show an equivalent circuit of an existing TFT-LCD. An input signal supplied to the existing TFT-LCD is described below by referring to FIGS. 3 and 4. A controller 31 converts image data into a form to be supplied to an X-driver 33 and a Y-driver 35 of a driver IC. Moreover, an analog circuit 37 generates a voltage for each input signal. Input signals to be supplied to the TFT-LCD include a scanning signal (Vg) of a gate line 24 supplied from the Y-driver 35, a display signal (Vsig) of a data line 26 supplied from the X-driver 33, a common-electrode potential (Vcom) of a common electrode 30, and a storage capacitance line potential (Vcs) of a storage capacitance line 28. The potentials of these input signals are all supplied to the OLB electrode 60 extended from the pixel area in which the pixel electrodes 10 on the array substrate 12 are formed up to the perimeter of the area as shown in FIG. 2. Then, among the potentials of these input signals, the potential Vcom is supplied to the common electrode 30 through the transfer 62.

In general, a liquid crystal display must be inverted and driven by AC in order to prevent liquid crystal and alignment materials from deteriorating. In the case of a TFT-LCD, the polarity inverting and driving method is classified as shown below. First, the method is classified into the following two methods because of the difference of the polarity inversion cycle of Vsig at the array substrate side: frame inversion (F inversion) and row inversion (H inversion). Among these methods, driving methods in which the polarities of adjacent display signals Vsig are opposite to each other are referred to as column inversion (V inversion) and dot inversion (H/V inversion). In the case of the F inversion and V inversion, the polarity inversion cycle of the display signal Vsig is the same as the polarity inversion cycle of the pixel electrode potential. In the case of the H inversion and H/V inversion, however, the polarity inversion cycle of the display signal Vsig is equal to or less than "1/(number of gate lines)" of the polarity inversion cycle of the pixel electrode potential.

A driving method in which a polarity is inverted because the potential of a common electrode at the facing substrate side synchronizes with the display signal Vsig is referred to as common-voltage AC inversion driving (Vcom inversion) which is distinguished from a method in which common voltage is constant. The Vcom inversion driving has an advantage that the maximum voltage amplitude of the

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display signal  $V_{sig}$  can be decreased because the voltage amplitude of the common electrode biased to the voltage amplitude of the display signal  $V_{sig}$  is applied to a liquid crystal layer. It is requested from the market of the TFT-LCD to lower the price of the TFT-LCD and increase the number of gradations of it. To lower the price of the TFT-LCD, it is effective to lower the price of a display-signal driver IC which is most frequently used among driving-circuit parts for driving the TFT-LCD in addition to the improvement of the yield and throughput in the manufacturing process. To lower the price of the IC, it is effective to use the Vcom inversion driving method making it possible to form a display-signal driver IC in a low-withstand-voltage process with a power supply voltage of 5 V or lower used for a general-purpose IC. The Vcom inversion driving is effective means to meet the market request for the TFT-LCD because it allows the number of gradations to easily increase.

Because it is necessary to make the polarities of all the display signals  $V_{sig}$  written in the pixel electrodes same under the Vcom inversion driving, it is impossible to perform V inversion or H/V inversion of adjacent display signals  $V_{sig}$  with different polarities. Therefore, it is necessary to apply F inversion or H inversion to the display signals  $V_{sig}$ . However, under the F-inversion driving, many display irregularities of screen flickers or crosstalk are observed. Therefore, combination with H inversion is practical. In fact, a TFT-LCD using the driving method according to the combination of H inversion and Vcom inversion (H/com inversion) is widely marketed.

In recent years, requests for increase in size and improvement in definition of a liquid crystal display have been strengthened according to increase of information content. However, the H/com inversion driving method is restricted in view of design for increase in size and improvement in definition of the liquid crystal display. It is inevitable to use a material with a high electric resistance such as ITO for the common electrode 30 (FIG. 2) of a TFT-LCD because the electrode requires transparency. As a result, the electric resistance from a potential supply terminal to the central portion of a display screen according to increase of a display screen in size. Moreover, to improve the definition of the display screen of a TFT-LCD, it is necessary to increase the number of indicatable rows. However, because the polarity inversion cycle of Vcom synchronizes with the selection time of a scanning signal in the case of the H/com inversion driving, the potential fluctuation cycle of Vcom shortens by being inversely proportional to the number of scanning lines (=number of gate lines), that is, the number of indicatable rows of the display screen.

Therefore, according to increase in size and improvement in definition of a TFT-LCD, the electric resistance of a common electrode increases and the potential fluctuation cycle of Vcom shortens. As a result, a problem occurs that a signal delay of Vcom happens, that is, Vcom cannot follow an input signal to be inputted to a common electrode around the central portion of a display screen. FIG. 5 shows the state of the signal delay of Vcom. In this case, the polarity inversion cycle of Vcom at the time of H/com inversion is assumed as 1 H. The problem of the signal delay of Vcom appears as a problem of the image quality such as irregularity of the display screen or decrease of the display contrast ratio in the case of a large high-definition TFT-LCD with a diagonal of 50 cm and display of approx. 1,000 rows. The problem of the signal delay of Vcom also occurs in a normal-size TFT-LCD.

Moreover, as shown in FIG. 2, the transparent spherical spacers 36 (made of plastic and glass fiber) are hitherto

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scattered in the liquid crystal layer 34 held by the array substrate 12 and the facing substrate 14 constituting a liquid crystal display in order to keep the substrates 12 and 14 at a predetermined interval. However, under the spacers kept scattered, liquid crystal flows in a panel when an external force is applied to the panel, the spacers are moved in a cell plane due to the flowing of the liquid crystal, and thereby the spacers may scratch the surface of the thin alignment film 54 due to the movement of the spacers. Moreover, a cell gap (interval between electrodes of two substrates) may not be kept constant due to coagulation of the spacers. Unless the cell gap is kept constant, the optical path length difference (product of the birefringence rate and cell gap of the liquid crystal) of the liquid crystal layer changes and thereby, the contrast ratio and the chromaticity of a display screen are changed. Thus, problems occur that the uniformity of the screen cannot be kept or the display quality is deteriorated. Moreover, the spacers are brightened or coagulated, and the light from the backlight 68 is cut off by the coagulated spacers and thereby the screen is blackened by the degree of cut-off light. To solve these problems, various structures are already disclosed which disuse transparent spherical spacers and instead, specify a cell gap by a pillar formed on the array substrate 12 and/or the facing substrate 14 (official gazettes of Japanese Patent Laid-Open Nos. 164723/1985, 105583/1986, 24230/1989, 134733/1986, 163428/1902, 250416/1987, and 196946/1993). However, any one of these disclosures does not show means for solving the problem of signal delay in a TFT-LCD using the H/com inversion driving method.

Moreover, as shown in FIG. 2, the existing TFT-LCD has a problem in the structure of supplying the potential of the common electrode 30 on the facing substrate 14 from a plurality of portions at the perimeter of a pixel area of the array substrate 12 side to the common electrode 30 on the facing substrate 14 through the transfer 62 using conductive paste. Because this structure requires a high-accuracy alignment of the transfer 62, it uses two or more transfers to prevent defectives from being produced due to a deviation of a transfer. However, the manufacturing yield is decreased due to defectives produced in a process for dotting a transfer. Moreover, there is the restriction on design that an area for dotting a transfer must be formed at the perimeter of a pixel area. That is, because an area independent of display must exclusively be formed on the array substrate 12 and the facing substrate 14, an effective display area to a substrate size is decreased. However, it is inevitable to use the above structure because it is indispensable for an existing liquid crystal display in view of design.

#### SUMMARY OF THE INVENTION

It is an object of the present invention to provide a TFT-LCD making it possible to prevent a signal delay from occurring even around the central portion of a common electrode and moreover prevent irregularity of a display screen and decrease of a contrast ratio from occurring.

It is another object of the present invention to provide a TFT-LCD making it possible to keep a cell gap constant without using spacers.

It is still another object of the present invention to provide a TFT-LCD making it possible to supply a potential to a common electrode on a facing substrate without dotting a transfer.

As shown in FIG. 8, the present invention uses a pillar 78 of a color filter 32 instead of a spacer in order to keep a cell gap between two substrates constant. Then, a signal delay of

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a common electrode 30 is prevented from occurring by forming a portion for electrically connecting a common electrode 30 covering the pillar 78 of the color filter 32 with a storage capacitance line 28 everywhere in a pixel area and supplying a potential of the common electrode 30 from the storage capacitance line 28.

According to the present invention, the potential of the storage capacitance line 28 is supplied to the common electrode 30 on a facing substrate from joints formed everywhere in a pixel area. Originally, the common-electrode potential (Vcom) is frequently equalized with the storage capacitance line potential (Vcs) and the both potentials are supplied from the same supply source in most cases when going back to a driving circuit. Therefore, there is no problem in supplying Vcs as Vcom. Moreover, because transparency is not always requested for a material for forming a storage capacitance line, a metal with a small electric resistance is generally used as the material of the line. Therefore, by using the above structure, it is possible to supply the potential Vcom in which no signal delay occurs even around the central portion of a common electrode and prevent the existing problem on display characteristics caused by a signal delay of Vcom and due to increase in size and improvement in definition of a liquid crystal display. Moreover, this structure can be applied to TFT-LCDs other than a large or high-definition TFT-LCD and moreover applied to cases other than H/com inversion driving.

According to the above advantage, it is unnecessary to connect a storage capacitance line with a common electrode at every linkable portion and it is enough that the line and the electrode are connected at only tens of portions among millions of linkable portions. Therefore, by using the above structure, a defective due to stop of supply of a potential to be supplied to a common electrode does not occur. Moreover, it is possible to disuse a transfer set at the perimeter of a pixel area and a spherical spacer specifying a cell gap. Therefore, the productivity is improved, the number of restrictions on design is decreased, and display quality is improved. As for a transfer, because it is unnecessary that an area independent of display must hitherto be formed on an array substrate and a facing substrate and thereby an effective display area to a substrate size is decreased, it is possible to decrease the size of a liquid crystal display in the same pixel area.

However, it is possible to set the transfer and spherical spacer as ever. Moreover, the above structure is also designed so that a disconnected storage capacitance line which has been defective can be repaired because a potential can be supplied to the line from a common electrode. However, power consumption does not increase by using the above structure. Moreover, when the height of a pillar set on a facing substrate is kept at 5  $\mu\text{m}$  or less, it is possible to prevent that a defective product is produced because a portion shaded by the pillar is not treated through rubbing and thereby causes incorrect orientation, even when using the pillar.

A pillar of a color filter on a facing substrate requires only change of mask patterns for the color filter but the number of processes does not increase. Moreover, it is possible to form a pillar by laminating red, green, and blue color filters or any two color filters of them. Furthermore, any sequence of colors to be laminated is not determined for a color-filter laminating portion. Furthermore, it is possible to fine-adjust a cell gap by forming a laminate structure containing a plurality of conductive materials at a position on an array substrate where a pillar is fitted on a facing substrate, connecting the laminate structure to a common electrode on

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the facing substrate through a conductive body layer electrically connected to a storage capacitance line, and specifying the cell gap by the sum of the height of the laminate structure on the array substrate and that of the pillar on the facing substrate.

Furthermore, it is possible to use a structure for orienting liquid crystal by rubbing an alignment film used for many liquid crystal displays currently marketed. Because the alignment film is softer than a storage capacitance line material and a common electrode material, the alignment film is removed when the both materials contact each other and thereby, the both materials can electrically be connected.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows the structure of an existing TFT-LCD (perspective view);

FIG. 2 shows the structure of the existing TFT-LCD (sectional view of the structure in FIG. 1, taken along the line A—A of FIG. 1);

FIG. 3 shows the equivalent circuit of the existing TFT-LCD;

FIG. 4 shows the equivalent circuit of the existing TFT-LCD (enlarged view);

FIG. 5 shows a signal delay of Vcom;

FIG. 6 shows the structure of the TFT-LCD of the present invention (perspective view);

FIG. 7 shows the equivalent circuit of the TFT-LCD of the present invention;

FIG. 8 shows the structure of the TFT-LCD described in the embodiment 1 of the present invention (sectional view of the structure in FIG. 6, taken along the line B—B of FIG. 6);

FIG. 9 shows an enlarged view of the picture-element section of the TFT-LCD described in the embodiment 1 of the present invention;

FIG. 10 shows an enlarged view of the picture-element section of the TFT-LCD described in the embodiment 2 of the present invention; and

FIG. 11 shows an enlarged view of the picture-element section of the TFT-LCD described in the third embodiment of the present invention.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

The liquid crystal display panel 70 of the embodiments 1 to 3 of the present invention is described below by referring to FIGS. 6 to 11. The liquid crystal display panel 70 of these embodiments uses an active-matrix-driving liquid crystal display.

In the case of the embodiment 1, the liquid crystal display panel 70 is provided with an array substrate 12 and a color filter substrate 72 on which a color filter 32 is formed as a facing substrate as shown in FIGS. 6 to 8. Moreover, as shown in FIG. 8, an undercoat layer 42, a gate electrode 20 (gate line 24), a pixel electrode 10, a gate insulating film 44, a semiconductor layer (channel layer) 46, a channel protective layer 48, an ohmic contact layer 50, a passivation film 52, and an alignment film 54 are formed in order on the array substrate 12. Among these layers and films, the undercoat layer 42, channel protective layer 48, passivation film 52, and alignment film 54 may not be formed. Moreover, as shown in FIG. 9, a TFT 16 is arranged near the intersection between the gate line 24 and the data line 26 and the gate electrode 20 of the TFT is formed by extending part of the gate line 24 and the drain electrode 22 of the TFT is formed

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by extending part of the data line 26. The source electrode 18 of the TFT is electrically connected to the pixel electrode 10.

Furthermore, as shown in FIG. 8, the embodiment 1 may have a structure in which the gate insulating film 44 is formed on the storage capacitance line 28 in a pixel area on the array substrate 12. That is, the embodiment 1 has a structure in which a hole 76 is formed at part of the gate insulating film 44 on the storage capacitance line 28, the common electrode 30 at a portion covering the pillar 78 of a color filter formed on the color filter substrate 72 is overlapped with the position of the hole 76, and the common electrode 30 contacts the storage capacitance line 28 so that they are electrically connected each other. Though the storage capacitance line 28 contacts the common electrode 30 on the color filter substrate 72 through the hole 76 of the gate insulating film, the alignment film 54 may be formed on the whole surfaces of the pixel areas of the array substrate 12 and the color filter substrate 72 at the contact plane between the line 28 and the substrate 72. However, also in this case, by rubbing the alignment film 54 covering the storage capacitance line 28 viewed through the hole 76 on the array substrate 12 with the common electrode 30 covering the pillar 78 on the color filter substrate 72 when superimposing the array substrate 12 on the color filter substrate 72, part of the alignment film 54 is shaved and the storage capacitance line 28 is electrically connected with the common electrode 30. For this, the object of the present invention is achieved when only tens of portions are connected among millions of linkable portions. Therefore, there is no problem even if there are imperfectly-connected portions.

Moreover, the present invention does not require a spherical spacer for specifying a cell gap or transfer for supplying a potential to the common electrode 30 as shown in FIG. 8. However, there is no problem in using the spacer and transfer. The equivalent circuit of the TFT-LCD of the present invention is shown in FIG. 7 for comparison with the circuit in FIG. 4. As shown in FIG. 7, the advantages are obtained that the problem of signal delay of Vcom is solved because Vcom is equal to Vcs everywhere in a screen by applying the present invention and it is unnecessary to independently supply Vcom from the outside.

As another method for connecting a common electrode with a storage capacitance line, the storage capacitance line 28 may be formed on the pixel electrode 10 formed on the array substrate 12 through the insulating film 74. In this case, a joint 80 between the storage capacitance line 28 and the common electrode 30 covering the pillar 78 of a color filter is three-dimensionally superimposed on a storage capacitance area 82.

In the case of the third embodiment, a layer 84 made of a conductive body such as a metal formed simultaneously with the data line 26 is first formed on the storage capacitance line 28, and then it is connected with the common electrode 30 to constitute the joint 80 instead of directly connecting the common electrode 30 to the storage capacitance line 28 like the first and second embodiments. Therefore, it is possible to perform fine adjustment for realizing an optically-optimized cell gap by the formation of the conductive body.

Then, the process for manufacturing the liquid crystal display panel 70 of this embodiment is described below.

First, the process for manufacturing the array substrate 12 is described below.

In the first process, the undercoat layer 42 is formed on the array substrate 12.

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In the second process, the gate electrode 20, gate line 24, and storage capacitance line 28 are formed on the undercoat layer 42.

In the third process, the gate insulating film 44 is formed.

In the fourth process, the semiconductor layer 46 of the TFT 16 is formed.

In the fifth process, the pixel electrode 10 is formed.

In the sixth process, the hole 76 is formed on part of the gate insulating film 44 on the storage capacitance line 28.

In the seventh process, the source electrode 18 and drain electrode 22 of the TFT 16 and the data line 26 are formed.

In the eighth process, the passivation film 52 covering the TFT 16 is formed.

In the ninth process, the alignment film 54 is formed and treated through rubbing.

Then, the method for manufacturing the color filter substrate 72 is described below.

In the first process, the color filter 32 is formed on the facing substrate 14, and the pillar 78 of a color filter is formed at a position corresponding to the hole 76 on the array substrate 12.

In the second process, the common electrode 30 is formed on the color filter 32.

In the third process, the alignment film 54 is formed and treated through rubbing.

The array substrate 12 and the color filter substrate 77 finished through the above processes are made to face each other and the storage capacitance line 28 viewed through the hole 76 on the array substrate 12 is overlapped with the common electrode 30 at the portion covering the pillar 78 of a color filter on the facing substrate 14 to electrically connect them each other.

Then, the liquid crystal display panel 70 is finished by sealing the perimeter of the assembly with a sealant 64, injecting liquid crystal into the assembly through an injection hole (not illustrated), and closing the injection hole.

The present invention provides a large high-definition liquid crystal display without causing a signal delay even around the central portion of a common electrode. Moreover, because the present invention disuses processes for scattering spacers and dotting transfers, the yield is improved and the cost is decreased.

I claim:

1. A color filter and common electrode carried by a facing substrate for assembly with an array substrate to form a liquid crystal display panel, the color filter comprising a plurality of pillars formed higher than other portions of the color filter for contact with objects formed on the array substrate to specify a cell gap, wherein the pillars are covered with the common electrode.

2. The color filter according to claim 1, wherein the pillars have a laminate structure made of at least two color materials of red, green, and blue color-filter forming materials.

3. A liquid crystal display panel comprising:

an array substrate having pixel electrodes arranged like a matrix, an active element for each of the pixel electrodes, a storage capacitance provided at some of the pixel electrodes, and a storage capacitance line for outputting the reference potential of the storage capacitance;

a facing substrate having a plurality of pillars arranged so as to face the array substrate, the pillars being formed higher than other portions of the facing substrate, the pillars together with objects formed on the array sub-

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strate that face the pillars specifying a cell gap, and a common electrode for all pixels covering at least some of the pillars, the common electrode being electrically connected to the storage capacitance line at the portions of the common electrode covering the pillars; and

a liquid crystal layer held between the array substrate and the facing substrate.

4. The liquid crystal display panel according to claim 3, wherein the facing substrate has red, green, and blue color filters formed correspondingly to the pixel electrodes and the pillars are made of color-filter forming materials.

5. The liquid crystal display panel according to claim 4, wherein the pillars have a laminate structure of at least two color materials of red, green, and blue color-filter forming materials.

6. The liquid crystal display panel according to claim 3, wherein the storage capacitance line has a laminate structure of a plurality of conductive materials where the common electrode is electrically connected to the storage capacitance line at the pillars.

7. A liquid crystal display comprising:

an array substrate having pixel electrodes arranged like a matrix, an active element for each of the pixel electrodes, a storage capacitance provided at some of the pixel electrodes, and a storage capacitance line for outputting the reference potential of the storage capacitance;

a facing substrate having a plurality of pillars arranged so as to face the array substrate, the pillars being formed higher than other portions of the facing substrate, the pillars together with objects formed on the array substrate that face the pillars specifying a cell gap, and a common electrode for all pixels covering at least some of the pillars, the common electrode being electrically connected to the storage capacitance line at the portions of the common electrode covering the pillars;

a liquid crystal layer held between the array substrate and the facing substrate; and

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a polarizing film set at least either of the top of the facing substrate and the bottom of the array substrate.

8. The liquid crystal display according to claim 7, wherein a driver IC and a backlight for emitting light are included.

9. A liquid crystal display panel manufacturing method comprising the steps of:

determining the height of a laminate structure and storage capacitance line to be formed on an array substrate, the laminate structure including a plurality of conductive materials electrically connected with the storage capacitance line, and determining the height of pillars of a color filter to be formed on a color filter substrate so that the sum of these heights specifies the distance between the array substrate and the color filter substrate;

forming the storage capacitance line on the array substrate and the laminate structure on the storage capacitance line, the array substrate having pixel electrodes arranged like a matrix and active elements arranged in the vicinity of the pixel electrodes, so that the storage capacitance line and the laminate structure have the determined height thereof;

forming the color filter at positions corresponding to the pixel electrodes on the color filter substrate and also forming pillars of the color filter so that the pillars have the determined height thereof;

superimposing the array substrate and the color filter substrate so that the laminate structure and the pillars of the color filter butt each other and sealing the circumferences of the superimposed array substrate and color filter substrate; and

injecting liquid crystal between the array substrate and the color filter substrate whose circumferences are sealed.

10. The liquid crystal display panel manufacturing method according to claim 9, wherein the pillars are formed of color filter material simultaneously with the color filter.

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